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The Asia Science Letter is a quarterly publication of the Asian Office of Aerospace Research and Development (AOARD), Detachment 2 of the US Air Force Office of Scientific Research (AFOSR), the basic research manager of the Air Force Research Laboratory (AFRL). Its purpose is to inform the Air Force S&T community on the research and development activities in Asia and Pacific Rim countries including India and Australia. The assessments in this periodical are solely those of the authors and do not necessarily reflect official US Government, US Air Force, or AFOSR positions.

Highlights

Singapore is one of the fastest growing technical powerhouses in Asia. A Technical Team led by the Executive Director of the Air Force Research Laboratory, Mr. Robert May, visited Singapore from 9-14 Nov 02. Organizations visited included the Defence Science and Technology Agency (DSTA), the Defence Science Organization (DSO), Temasek Laboratory, the Defence Medical Research Institute (DMRI), the Air Force Aeromedical Center (ARMC), the Institute of Materials Research and Engineering (IMRE), the Institute for High Performance Computing (iHPC), and Singapore Technologies Aerospace. For other Singapore activities see Dr. Lyons' articles on the Institute for Defense Analysis visit to Singapore to explore biotechnology (see page 3) and Dr. Ken Goretta's article on the Institute of Materials Research and Engineering (IMRE) (see page 9).

The DARPA Director, Dr. Tony Tether, visited Japan and on October 25 was briefed by Dr. Lyons and Ms. Maurice on AOARD's activities in wide band gap materials, artificial intelligence, and hypersonics.

The AOARD sponsored Future of AI Workshop held in Izu, Japan (13-15 December 2002) was attended by top researchers in AI from both Japan and the U.S. including Dr. Ron Brachman (new Director of the DARPA Information Processing Techniques Office and President of the American Association for AI), Professor Edward Feigenbaum (Stanford), and Dr. Eric Horvitz (Senior Researcher at Microsoft) (see page 4).

Japan won two Nobel Prizes this year. Dr. Koshiba from the University of Tokyo used the Japanese Kamiokande facility to characterize space neutrinos and won the Prize in Physics. And Dr. Tanaka from Shimadzu Corp., who developed the soft laser desorption method for the analysis of large protein biopolymers, won the Prize in Chemistry. Dr. Tanaka is the first Japanese industrial researcher to be awarded a Nobel Prize. This is the third year in a row Japan has won the Prize in chemistry.

Dr. Brett Pokines, an IPA from Rochester Institute of Technology arrived at AOARD on January 7, 2003 to cover AOARD's rapidly growing activity in the area of Nano and MEMS technology. Brett has previously assisted AOARD on a part-time basis, but we are pleased that this time he will be staying full-time for a two year period.

Congratulations are in order for LtCol John Brewer, a reservist assigned to AOARD as he was selected for promotion to Colonel. Col(s) Brewer is a Bioenvironmental Engineer who helps with our biotechnology projects plus provides support for AOARD projects in Singapore.

Terence J. Lyons, M.D., M.P.H.
Director

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Feature

Mr. Robert May, Executive Director of the Air Force Research Laboratory, visits Singapore

A Technical Team led by the Executive Director of the Air Force Research Laboratory, Mr. Robert May, visited Singapore from 9-14 Nov 02. Organizations visited included the Defence Science and Technology Agency (DSTA), the Defence Science Organization (DSO), Temasek, Defence Medical Research Institute (DMRI), Air Force Aeromedical Center (ARMC), Institute of Materials Research and Engineering (IMRE), Institute for High Power Computing (iHPC), and Singapore Technologies Aerospace.

1. Temasek: Temasek is responsible for basic research for the Singapore Armed Forces. They are currently building up their in-house research team and capabilities and the current staff of 66 should soon grow to 87. In-house research Programs in electromagnetism, aerodynamics, information security, signal processing, meteorology, and non-linear dynamics are being developed. Construction projects are ongoing including a National Wind Tunnel (completion in 2003) and an Electromagnetic Compatibility Center for EMI and EMC research (completion in 2005-2006). The blow-down wind tunnel is designed for Mach 0.25 to Mach 4, with a 1.2m x 1.2m test section and a 40s run time.

2. Defence Medical Research Institute (DMRI): The Defense Medical Research Institute (DMRI) was inaugurated in 1995 to meet the medical research needs of the Singapore Defence Forces. With a staff of 100 including 87 researchers, DMRI conducts research in human factors, clinical sciences and biomedical sciences. Research activities include DNA fingerprinting, biochips, drug delivery systems, vision ergonomics and visual performance, bio-dynamics (neck injury including CG of the head and neck with aircrew equipment), thermal stress (developed an ingestible heat sensor), infectious disease (including arthropod-borne diseases), fatigue (including diet and ergogenic aids), anthropometry, medical informatics, telemedicine, human systems integration, motion sickness, human error, traumatology, medical technologies for casualty management, toxicology, and molecular genetics. With an 85% prevalence of myopia in Singapore, DMRI is investigating the performance effects of myopia, the use of long wear contacts, and the genetic basis of myopia. In addition to its in-house research, DMRI also manages contract research such as myopia investigations at the Singapore Eye Research Institute (SERI) and the Spinal Project - an NTU School of Mechanical and Production Engineering effort to model of the complex movement of the spine and force measurements in multiple positions with a focus on the C-5 to C-7 vertebrae.

3. Air Force Aeromedical Center (ARMC): The Air Force Aeromedical Center opened in 1982 and has a staff of 140 in Departments of Clinical Aviation Medicine, Aviation Psychology, Aviation Physiology and Training, and Performance Maximization. It is well equipped with state of the art human centrifuge (G-FET installed in 1995), Vertifuge, altitude chamber (21 place), somatogyral turntable, and night vision training room. The Center's Aviation Physiology Training Program has been certified by the USAF. With 60% pilot attrition in the Singapore Air Force, the Center is actively implementing a computerized pilot selection system and a motion sickness desensitization program - with a 50%-60% desensitization success rate. The Center has outsourced its aircrew selection and training activities; since 1993 these services have been provided in-house by Singapore Technologies Medical Services Pte Ltd. The Performance Maximization Branch conducts research and collaborates actively with DMRI (see above).

4. Institute of Materials Research and Engineering (IMRE): See Dr. Goretta's article on IMRE on page 9.

5. Institute for High Performance Computing (iHPC): This is a newly established governmental, but commercially subsidized, research organization with state-of-the-art facilities in the areas of dynamic modeling and 3-D visualization, including a 10'x10'x10' CAVE virtual reality system. The AFRL team heard briefings on research in High End Computing, computational mechanics, and Computational Fluid Dynamics with applications in biofluids, fire & smoke modeling, and coastal environmental protection.

Singapore's two major universities, the National University of Singapore and Nanyang Technological University, are committed to research that will support industrial development. Singapore military research organizations such as DSO, DMRI, and ARMC cooperate extensively with these academic institutions. Both of these institutions are very dynamic and interested in pursuing areas of mutual interest for future research collaboration.

Singapore has a modern infrastructure and cutting-edge technical facilities. Academic, military, and other government agencies in Singapore work closely and effectively together. Both universities and the government focus on making R&D investments in areas that will provide them niche dominance and leverage in international cooperative work. Leaders and scientists are very international in outlook and open to international collaboration. (Lyons)

General News

The Institute for Defense Analysis Explores Biotechnology Activity in Singapore

Mr. Gordie Boezer and Dr. Ray Wick from the Institute for Defense Analysis (IDA), Mr. Joe Golden from the Defense Threat Reduction Agency, and Dr. Terence Lyons from AFOSR/AOARD visited Singapore 7-12 November to explore research and development activities in biotechnology. Singapore established a goal of become a center for biomedical science activities in Asia. By building on existing capabilities in the electronics, precision engineering, and chemical processing, Singapore is making significant investments in the pharmaceutical, medical technology, biotechnology, and healthcare industries. On November 11 the team visited the Singapore Economic Development Board which is investing over US\$1.2B in private sector biomedical science. To complement this, the Singapore government is investing an additional US\$1.2B over the next five years through the National Science and Technology Board and A-STAR Research Institutes. Tuas Biomedical Park is already a manufacturing site for six major pharmaceutical companies. A new biomedical science park "Biopolis" will be completed by 2003. (Lyons)

Site Visit: Nanyang Technological University (NTU), Singapore, 8 November 2002. NTU and the National University of Singapore (NUS) are the two major universities in Singapore. NTU concentrates on technical education, while NUS also has major offerings in medicine, law, social sciences, and other academic specialties. Currently NTU has 1,800 faculty and 9,000 graduate students. Student output has shifted to be heavily Ph.D. oriented since 1999. The dean for the School of Mechanical and Production Engineering Dr. Yue Chee Yoon stated that Singapore has targeted three areas for economic growth and development: electronics, life sciences and petrochemicals.

School of Biological Science: A visit was conducted with two professors from the new School of Biological Science: Drs. William Chen and Lars Nordenskiöld. Their goal is a staff of 30 in one and a half years composed of 50% domestic and 50% international scholars. We walked through three new or newly equipped laboratory spaces within the School and saw the busy construction site for a new biological sciences facility. This S\$68M building is to be completed in 2004.

School of Mechanical and Production Engineering: Research areas at the school include advanced electronic materials, nano-powders, biomedical engineering, biomaterials, design & modeling, intelligent systems & robotics, nano/MEMS (including bio-MEMS, sensors, actuators, and thin films), environmental research, and energy (fuel cells). We then saw projects and visited with principal investigators from both the

School of Mechanical and Production Engineering and the School of Biological Sciences including:

1. Biomedical Engineering Research Center (Dr. S. M. Krishnan, School of Electrical and Electronic Engineering): This Centre had a broad range of interests including knee implants, artificial hearts, blood pumps, stents, telemedicine, MRI, and AI supported on-site signal processing.
2. The Spinal Project (Dr. Teo Ee Cheon, School of Mechanical and Production Engineering) uses a finite element model of bones and ligaments, 3,000 elements per vertebrae, to model the complex movement of the spine and force measurements from vertebrae C-5 to C-7.
3. The Computer Integrated Medical Intervention Laboratory (Dr. Ng Wan Sing, School of Mechanical and Production Engineering) conducts research on applications of VR for use in medical procedures and for training medical personnel including prostate biopsy, colonoscopy, and others.
4. The Tissue Engineering Laboratory (Dr. Chian Kerm and Dr. Vincent Chan, both of the School of Mechanical and Production Engineering) focused on growing biological materials on various substrates, noting their traits, controlling the process and taking measurements of their growth processes and characteristics. The research enables tissue to adhere to inorganic surfaces while maintaining functionality. They have grown tissues on glass and on polymer films. They are addressing the question of using a metallic substrate such as gold.
5. The presentation of the MEMS Strategic Research Program/Array PCR (Dr. Thomas Gong, School of Mechanical and Production Engineering) included some micro-fluidics work and showed a slide with multiple wells to do multiple analyses simultaneously.
<http://www.ntu.edu.sg/sbs>
<http://www.ntu.edu.sg/mpe/> (Lyons)

Aerospace and Mechanical

Conference: The Inaugural Australasian Workshop on Structural Health Monitoring, Monash Australia, 25-26 November 2002. This AOARD supported workshop provided a forum for Australians involved in structural health monitoring to meet and compare ideas (1). Monash University was an appropriate location as researchers at the university have a long history of work with both AFRL and the counterpart Australian DSTO on topics relating to structural integrity and health monitoring. Monash University, is also home to the Institute of Railway Technology which has a long history with railway structural integrity and health monitoring issues (2). Nearby in Melbourne is the DSTO

Platform Sciences Division, one of the world's leading centers of aging aircraft expertise (3). Keynote talks were provided by Prof. FuKuo Chang of Stanford University and Ms. Carolyn Southern of Australian Railtrack Corporation Ltd. (Nowack)

1. <http://www-personal.monash.edu.au/~chiuw/workshop/workshop.htm>
2. <http://www.eng.monash.edu.au/railway/>
3. <http://www.dst.defence.gov.au/psl/psl.html>

Conference: The Third Australian Conference on Laser Diagnostics in Fluid Mechanics and Combustion, Brisbane Australia, 2-3 December 2002. Hosted by the University of Queensland and supported by AOARD, this workshop brought together researchers from the fluid mechanics and combustion communities to share ideas (1). Australia's strong hypersonic research community was well represented with presentations from the Univ. of Queensland (2), Australian National University (3), the University of New South Wales at the Australian Defense Forces Academy. The combustion research groups at Adelaide (4) and Monash Universities (5) were also well represented along with work at the University of Sydney.

Prof. Takayama of Tohoku University presented a keynote talk on work at the Shock Wave Research Center (6). AFRL's Dr. Mark Gruber presented a keynote talk on Air Force interests in high-speed flows. The workshop was followed by a hypersonics workshop included representation from AFRL and AEDC. (Nowack)

1. <http://www.physics.uq.edu.au/lp/lasdiag/lasdiagconf/>
2. <http://www.mech.uq.edu.au/hyper/>
3. <http://www.anu.edu.au/physics/aldir/>
4. <http://www.tec.adelaide.edu.au/>
5. <http://colossus.eng.monash.edu.au/~trl/>
6. http://www.ifs.tohoku.ac.jp/dv_swr_e.html

Computation and Communication

Conference: US-Japan Future of Artificial Intelligence Workshop, 13-15 December, 2002, Izu, Japan. This invitation only workshop was held at IBM Amagi Homestead, a retreat facility of IBM-Japan. It was initially conceived by Prof. Edward Feigenbaum with the purpose of assessing the current state of AI research, and formulating guidance for the future research directions. The 4-member steering committee (Edward A. Feigenbaum of Stanford Univ., Setsuo Ohsuga of Waseda Univ., Hiroshi Motoda of Osaka Univ., Koji Sasaki of AdIn Research, Inc.) selected 30 panelists, 10 from US and 20 from Japan. The panelists were divided into 7 sub-panel groups:

1. Foundations Of AI: the future of logical knowledge representation and logical reasoning by computer
2. Discovery: machine learning and knowledge discovery, and the future of those research areas

3. Human-Computer Interface: Human-Computer Interaction and AI, for example in Computer Supported Cooperative Work (CSCW)

4. AI Systems: scaling up AI systems into large systems such as multi-tasking systems, possibilities of super-intelligent-systems as an extension of expert system capabilities, and integration of different methods for problem solving

5. Human-Level Intelligence: computational models of "emotional" processing: are they important?, possibilities of "human-level intelligence" as an AI vector, creativity: AI and computational models of creativity, and the importance of coupling the "robotics" work of AI with its "cognitive" work, i.e. "putting a mind in a robot"

6. Knowledge Processing: ontologies, semantic web and intelligent web services, and knowledge management in organizations

7. Synthesis, Summaries, Responses and Other Topics: contemporary definition of AI, opportunities missed by not coupling closer with neuroscience--to the science of how the Human brain works, and topics such as "dissident views" and "what have we missed?"

Notable panelists included Dr. Ron Brachman, Director of the DARPA Information Processing and Dr. Eric Horvitz, Group Manager, Adaptive Systems & Integration Group, Microsoft Research. AOARD plans to publish a final report of the workshop which will include executive summary, presentation materials, discussion transcripts and sub-panel summaries. The workshop was a great success with many enthusiastic responses from panelists, and the panelists unanimously recommended for a follow-on workshop in two years. This workshop has received strong endorsement from NSF (USA) and Ministry of Economy, Trade, and Industry (Japan). Additional support came from AFOSR/NM, AFOSR/AOARD, and ARO-FE, and 10 Japanese corporations (Canon, Inc., Fujitsu Laboratories Ltd., Fuji Xerox Co., Ltd., Hitachi, Ltd., IBM Japan, Ltd., NEC Corporation, NTT DoCoMo, Inc., AdIn Research, Inc., Alliance Group, Inc., and Advanced BioMedicare Research Inc. (Park))

<http://www.geocities.co.jp/Technopolis-Mars/5176/>

Conference: 2002 IEEE International Conference on Data Mining (ICDM-02), 9-12 December 2002, Maebashi, Japan. This AOARD-supported conference received 350 submissions from 36 countries, with 73 papers accepted for regular track presentation. Although the U.S. led in the number of submissions (94), Asian countries had a strong showing: Australia (24), China (31), Japan (22), Taiwan (32). Among the highlights was a keynote talk by Fields Medal recipient Prof. Steve Smale of the University of California at Berkeley titled "Dealing with Data and the Mathematics of Learning" which focused on an algorithm based on linear algebra going back to Gauss, and its modern form via Tikhonov and Poggio. He presented an elegant mathematical formulation for the supervised learning model. The best paper

Electronics and Physics

award for the conference was titled "Convex Hull Ensemble Machine" by Prof. Yongdae Kim. Prof. Kim's paper reported a preliminary results of his on-going AOARD sponsored research to develop a statistical theory of machine learning. <http://www.cs.uvm.edu/~xwu/icdm-03.html> (Park)

Site Visit: Centre for Quantum Computer Technology, University of New South Wales, Sydney, Australia, 30 October 2002. The Centre for Quantum Computer Technology is an Australian Research Council Special Research Center supported by four Cabinet-level departments. Its Director is Robert G. Clark of the University of New South Wales (UNSW). The Centre received an initial injection of A\$10M with further funding of A\$30M spread over four years. In addition, existing facilities worth many tens of millions of dollars have been assigned to the Centre.

The Centre has established six goals: (1) To construct and characterize a small qubit device that will constitute the building block for a larger Si-based quantum computer. (2) To develop fabrication technology based on an array of P donors embedded within an Si-based crystal. (3) To maintain capabilities in fundamental science of quantum-effect semiconductor nanostructures of relevance to Si- or GaAs-based quantum computing. (4) To develop detailed models of, and algorithms for, Si-based quantum computing. (5) To demonstrate algorithms operating on multi-qubit solid-state quantum computing devices. (6) To explore promising alternative designs for quantum computers.

The Centre consists of 150 researchers and students distributed among five universities: UNSW, University of Queensland, University of Melbourne, Mcquarie University, and Griffith University. The first three universities comprise large programs, each of which is focused on a specific set of goals. The last two universities provide expertise in computer algorithms and linear photonics. Other academic and research institutions that have active collaborations with the Centre include the Australian Department of Defense, CSIRO, Hewlett-Packard (which had three Research Fellows in residence at UNSW), Australian National University, Los Alamos National Laboratory, and a few U.S. universities.

Supporting infrastructure has been designed and built rapidly and work has progressed significantly. The first prototype doped-Si device has been built and testing is now underway to determine its properties. This testing is envisioned to require one year to complete. Results to date have led to many domestic and international patents. To promote commercialization of all developed technology, and to safeguard the Centre's position, an independent company, Qucom Proprietary Limited, has been established to manage the intellectual-property portfolio. Its mission is to promote technology transfer and partnering and, ultimately, to help bring the Centre's revolutionary technology to the marketplace. <http://www.qcaustralia.org/> (Goretta)

Window-on-Science Visit: Asian Researchers travel to 2nd International Workshop on Zinc Oxide, Fairborn, OH, 23-25 October 2002: Several Asian researchers participated in the DoD-organized ZnO Workshop. A research group from Tohoku University in Japan that included Profs. Kawasaki, Yao, and Dr. Hang Ju Ko were sponsored under WOS to present work on development of an "invisible thin film transistor" with performance superior to invisible circuits made of amorphous silicon. Their device is based on the uni-polar property of ZnO which avoids the difficulty of previous approaches which rely on p-type transparent oxides, something ZnO lacks. They believe a thin-film transistor (TFT) made of ZnO might replace amorphous silicon TFT in liquid crystal displays. Prof. Yao, Dr. Ko, and their coworkers also presented results of a detailed study on the growth of high-quality ZnO on sapphire which showed high electron mobility comparable with the best quality ZnO bulk crystals and another paper on polarity control of ZnO layers grown on GaN and GaN grown on ZnO, thus suggesting feasibility of novel polarity inverted superlattice structures. Prof. Tae-Yeon Seong of K-JIST in Korea presented ZnO topics related to his AOARD-sponsored R&D project on surface treatments to improve n- and p-type ohmic and Schottky contacts. POCs for the Workshop were Drs. Cole Litton (AFRL/MLPS) and David Look (Wright State University). (Maurice)

Conference: 3rd Chitose International Forum on Photonics Science and Technology (CIF'3), Chitose Institute of Science and Technology (CIST) Chitose, Hokkaido, Japan, 6-8 October 2002. This third in the bio- and nano-inspired CIF series, convened in the heart of Japan's "Photonics Valley Project." One hundred international researchers plus 100 students participated. In addition to the general focus on organic photonics for nanotechnology, this year's Forum focused on biophotonics (light-matter interaction in biomaterials), photonic information networks, and organic photonic semiconductors, an area in which CIST is particularly active. Highlights included more than 20 invited speakers with novel approaches to devising organic nanomaterials and devices and a poster session covering recent research at CIST and in the biophotonics community.

Topics included the design, synthesis, and physical characterization of high-efficiency, organic, optically-active nanocomplexes for films, fibers, nanowires, nanocrystals and other structures, as well as application of these to passive and active device elements. Presentations reported on the development of photonic crystal fibers (for optical links, sensors, and diagnostics), a DFB (distributed feedback) solid-state dye laser based on an etchless process, new liquid crystal films, and fluorescent and phosphorescent bio-polymers. Samsung NEC Mobile Display Co., a joint venture based in Japan, presented 2.2 inch organic electroluminescent flat-panel color displays intended for cellular phones.

US presenters included Drs. Paras Prasad (SUNY Buffalo), and James G. Grote (AFRL/MLPS). Dr. Grote described joint work in an on-going AOARD R&D program with CIST Prof. Naoya Ogata. Joint U.S.-Japan work sponsored by NRL and DARPA was also presented. CIF'3 commemorated Prof. Naoya Ogata, former CIST President and pioneer in utilization of DNA for photonic applications. (Maurice)

2nd International Conference on Semiconductor Quantum Dots (QD2002), Komaba Campus, University of Tokyo, Tokyo, Japan, 30 September – 3 October 2002: Over 200 physicists, chemists and engineers from Europe, North America and Asia who participated in QD2002 were treated to a special lecture by Nobel Laureate Dr. Leo Esaki of the Shibaura Institute of Technology, entitled "Superlattices as Roots of New Physics and Electronics." It was Dr. Esaki who first proposed the concept of superlattices while at IBM, and whose discovery of the Esaki tunnel diode while at Sony constituted the first-ever quantum electron device.

The conference focused on optical and electronic properties of these novel, 3-dimensionally-confined structures. Group IV, III-V, and II-VI semiconductor materials grown by both epitaxy and chemical preparation methods were addressed in several topic areas:

- novel fabrication techniques and structural characterization,
- electronic structures, and electrical and optical (linear and nonlinear) properties of low-dimensional quantum and molecular structures,
- device applications (lasers, memories, photodetectors),
- coherent processes, quantum computation, and spin-coupled systems, and
- biomedical and other applications.

Amongst speakers from the U.S. were Prof. J. A. Lott of AFIT and D. Gammon of NRL. <http://www.qd2002.iis.u-tokyo.ac.jp/> (Maurice)

Window-on-Science Visits: 4th Symposium on Non-Stoichiometric III-V Compounds, Asilomar Conference Grounds, Pacific Grove, CA, 2-4 October 2002. Drs. Tsuyoshi Okuno (University of Tsukuba), Tokuo Yodo (Osaka Institute of Technology), and Takashi Inushima (Tokai University) participated in the Asilomar Symposium, presenting recent research results from their groups in Japan at this meeting of experts in non-stoichiometric III/V semiconductor compounds. Prof. Okuno's expertise is in the use of low-temperature-grown GaAs for use in ultra-fast optical switches. Material grown by his group exhibits a response of less than 1 picosecond over a wide range (wideband) of wavelengths. Prof. Yodo is an expert in film deposition and characterization of III-nitrides. He described stoichiometric control under the condition of plasma growth process and also the emission properties of material grown by electron cyclotron resonance plasma-assisted molecular-beam epitaxy. Prof. Inushima introduced work on the superconducting characteristics of InN. His group, previously active in defining the optical bandgap of this important III-V material, now report first-time observation of superconductivity in some of their samples grown on sapphire. Their results indicate that the superconducting characteristics

are not caused by indium clusters, but rather an anisotropic stoichiometry-related effect, and that the clusters can be excluded. Prof. Inushima's group works with InN which has a bandgap around 0.8 to 1.0 eV while Prof. Yodo's group grows InN with a bandgap of 1.9 to 2.2 eV. This and other findings initiated discussions.

The Symposium was AFOSR and ONR supported, the proceedings of which are dedicated to Dr. Jerry Witt (AFOSR/NE) for his achievements and guidance in non-stoichiometric III-V research over the years. POCs for the meeting were Dr. Petra Specht, Materials Science and Engineering Dept., University of California – Berkeley, and Prof. Todd R. Weatherford, Naval Postgraduate School. (Maurice)

Human and Biological Systems

Contract Awarded: "Measurement and Metrics for Multi-Layer Display Technology," Mr. Gareth Bell, Deep Video Imaging Ltd., Hamilton, New Zealand, December 2002. True 3D displays implemented via depth-multiplexed 2D active matrix liquid crystal displays (AMLCDs) have the advantage of requiring no user mounted equipment. However, this new approach presently has no basis in science to guide applied ergonomic research. This basic research effort is focused on the creation of concepts, mathematical models and metrics required to support later application studies. POC: Dr. Darrell G. Hopper (AFRL/HECV) (Park)

Window-on-Science Visits: "ab initio Molecular Dynamics," Maui High Performance Computation Center (MHPCC), HI, 18-20 December 2002. AOARD supported travel for six Asian researchers, as invited speakers, to participate at the symposium which was supported by the High Performance Computing Modernization Program, AFRL/ML, AFRL/PR, the University of Hawaii, and AOARD. The theme of the symposium was "ab initio Molecular Dynamics," and there were 16 active participants. The title and speakers from Australasian countries are:

- "ab initio Molecular Dynamics of the Photo-detachment of F-(H₂O) Anion Complex" by Kimihiko Hirao of University of Tokyo, Japan
- "ab initio Direct Dynamics Simulation Combined with the Surface Hopping Algorithm: An Application to the Dissociative Recombination Reaction of HCNH⁺ + e⁻ --> HNC/HCN + H" by Tetsuya Taketsugu of Ochanomizu University, Japan
- "Initial Oxidation Reactions of Si (100) Surface by Atomic Oxygen" by Cheol Ho Choi of Kyungbuk University, Korea
- "Is It Better to Use It and Lose It, or Remember the Best?" by Michael Collins of Australian National University

- "Conducting Properties of Molecular Electronic Devices" by Yoshiyuki Kawazoe of Tohoku University
- "Silicon Fullerenes" by Yoshiyuki Kawazoe of Tohoku University
- "Alkali Atom Adsorption on Si (111) 7x7 Surface" by Tina M. Briere of Tohoku University, Japan

As a result of this workshop, several potential research programs in computational chemistry were identified: a computational studies of Polyhedral Oligomeric Silsesquioxanes (POSS) by Prof. Takako Kudo of Gunma University, Japan, and development of powerful linear scaling methods to greatly enhance the ability to study surface chemistry, especially silicon surfaces, by Prof. Cheol Ho Choi of Kyungbuk University, Korea.

<http://www.mhpcc.edu/projects/AIMD/> (Park)

Conference: Technological activities of next generation displays (Toward the world's most advanced displays), Tokyo, Japan, 13 December 02. This symposium presented a New Energy and Industrial Technology Development Organization (NEDO) program (Focus 21) for next generation display technology that will run from 2003 to 2008. The symposia overviewed four projects from the seven in the program. Highlighted topics included:

- R&D of energy saving LCD processing technologies (Dr. Funada, ALTEDEC): The Advanced LCD Technologies Development Center (ALTEDEC) was established in 2001 as a consortium by eight private firms with NEDO support, and has been developing high performance and energy saving TFT technologies. System display integration with multifunctional IP units will be the final target.
- Next generation PDP (Dr. Shimoda, Fujitsu Corp.): Color PDP was originally developed in Japan 20 years ago. The immediate goal is in developing an 80 inch HDTV display.
- Field emission display (Dr. Okuda, Mitsubishi Electric Corp.): The Carbon Nano Tube (CNT) is considered the best electron emission cold cathode as compared to conventional technologies (Spindt, SED, BSD and MIM). The advantages of CNT are high emission current density, long life and low cost processing. Two main developmental issues are improvement of emission uniformity and large area packaging technology.
- Polymer organic ELD (Dr. Miyashita, Seiko Inc.): Ink-jet processing technology has been successfully applied to development of full color polymer ELD. Practical TV displays require brightness of 400 Cd/m², pixel density of 130 ppi, panel size of 1m x 1m, color range of 70 % and operation life of 30,000hrs. (Miyazaki)

Conference: The Ninth International Display Workshops (IDW'02), Hiroshima, Japan; 4-6 December 02. IDW is the largest international conference of display technologies in Asia. South Korea was especially well represented among the 1000 attendees and 400 presentations. South Korean advanced technology was especially evident. Mr. Hijikigawa of Sharp Corp. presented keynote address on 3rd generation display technology with CG Silicon, System Integrated Panel (SIP) and large area FPD processing.

Several highlights were as follows:

- High efficiency active matrix OLED (Dr. Cheng, Samsung SDI): High efficiency 2.2" AMOLED (Active Matrix OLED) was successfully developed using phosphorescent materials and optimizing device structure. The phosphorescent materials resulted in 50 % reduction in power consumption as compared to that of fluorescent devices. Maximum quantum efficiency will be forecasted up to 25% in 2005.
 - Development of 42"VGA PDP using LTCC-M Technology (Dr. Kong, Orion Electric Co.): Characteristics of 42" LTCC-M (Low Temperature Cofired Ceramic on Metal) PDPs and several factors to be considered in fabricating such large area panel were presented and reliability issues were addressed. The technology shows promise for back panel manufacturing.
 - Development of 2.2 in. Full Color AM-OLED Display for Mobile Applications (Dr. Mameno, Sanyo Elec.): Two kinds of device structures were developed; RGB-pixelization method and color-filter method with high-efficiency white organic emitting layer. Practical device characteristics were exhibited.
 - A special topical session was devoted to electronic paper. Major developments were expected to come through integration of polymer TFT, electrophoresis and plastic substrate (e.g. Epson Cambridge Lab. UK, and E Ink Co. US).
- IDW'03 will be held at Fukuoka, Japan in Dec 2003. IDW'02 proceedings are available by CD-ROM from the conference secretariat. (Miyazaki).
- <http://www.the-convention.co.jp/IDW/authinfo.html>

Conference: The International Congress on Biological and Medical Engineering, 4-7 December 2002, Singapore. The Congress incorporated the 5th Asia Pacific Conference on Biological and Medical Engineering and the 11th International Conference on Biomedical Engineering. The 550 participants represented 29 countries. The interdisciplinary program featured 7 plenary talks on general subjects, 39 invited keynote lectures, 56 oral sessions, and several large poster sessions. Topics included biomaterials, biomechanics, bionanotechnology, tissue engineering, computational bioengineering, bioinformatics, biomolecular engineering, physiological control, medical imaging, and neural systems engineering. Of particular note was the evidence in most countries of strong funding increases in life sciences. Progress in, for example, biomaterials and biotechnology has been rapid and is likely to accelerate. <http://www.icbme.org> (Goretta)

Conference: Direct observation of ultra super fine structure of molecule and its application to development of new functions, Tokyo, Japan, 22 November 02. To develop novel agricultural and marine products and biological raw materials, understanding the fine structure of bio materials and control of molecular structures must be developed. The AFFTIS (Agriculture, Forestry and Fisheries Technical Information Society) started a task force on "Direct observation of super fine structure of bio materials and control of molecular structure" in 2002 under support of the Ministry of Agriculture, Forestry and Fisheries of Japan. Task Force results will be utilized for establishing a five-year government project to begin in 2004. The 150 workshop attendees were

mainly from universities and private chemistry and pharmaceutical companies. Topical presentations were as follows:

- Cell nuclei and nucleic acid (Prof. Takeyasu, Kyoto Univ): Using advanced AFM (Atomic Force Microscope) they visualized complex DNA and intranuclear protein.

- Merging of nanotechnology and biotechnology (Dr. Hara, RIKEN): As an example of bio-interface, they developed single molecule operation method by hybridization of SNOM, AFM and STT.

- Overview of direct observation of ultra fine structure of protein (Prof. Ikai, Tokyo Institute of Technology): AFM searching of sources of Alzheimer disease and BSE, living cell manipulation and bio mineralization were main themes. Humic acid proved to be the best example of bio fractal structure.

<http://www.afttis.or.jp>. (Miyazaki)

Conference: 8th International Pacific Rim Biotechnology Conference, Auckland, New Zealand, 17 - 20 November 2002. New Zealand is a thriving Pacific Rim country with a global reputation for excellence in the biological sciences, due in part to research costs that are 1/3 the cost of similar work in the U.S. The 470 conference attendees represented 10 countries (New Zealand, Australia, Canada, China, India, Iran, Israel, Italy, Japan and Korea). Conference Themes included: biotechnology to enhance forestry, agribiotechnology, environmental biotechnology, food biotechnology, medical biotechnology, marine biotechnology, natural bioactives and botanical drugs, proteomics and bioinformatics, angel investors, venture capital, business planning and incubators for biotechnology projects, regulatory issues for biotechnology. Specific tracks included genomics, medical biotechnology, bioinformatics, environmental biotechnology, and fermentation.

One of the highlights was a presentation from Lincoln Ventures Ltd on a rapid microbial-based assay that can determine the biological oxygen demand (BOD) in one hour. The present method requires five days to complete. Their process substitutes the cell's natural co-substrate, O₂, with a water-soluble redox mediator that greatly accelerates microbial oxidation. (Brewer)

Site Visit: The National University of Singapore: Division of Bioengineering, Singapore; 9 November 2002 (Professor and Division Head, Nhan Phan-Thien). The recently formed Division of Bioengineering conducts research in tissue engineering, bio-signal processing, nano/micro mechanics, computational bioengineering, biomaterials, biophysics, and bio-nano-technology. Interesting projects include nanoparticles for drug delivery, functionally graded composite biomaterials, biomimetic membranes, and brain scanning with magneto-encephalography. <http://www.bioeng.nus.edu.sg> (Lyons)

Window-on-Science Visit: Associate Professor Sung-Ae Hong, Department of Clothing and Textiles, Hansung University, Korea, 2-5 October 2002. Kathleen Robinette (AFRL/HECP) hosted Sung-Ae Hong of South Korea. Dr.

Hong is an expert on 3-D pattern making and the manufacturing of apparel. Dr. Hong gave a presentation of her research on "Development and Evaluation of Functional and Protective Clothing System" and also presented the use of the macro function for automatic pattern generation for use in a pattern CAD system to provide a means for mass customization. As part of that effort, in the upcoming year Korea is undertaking a national anthropometric survey using a 3D body scanner. (Lyons)

Conference: AusBiotech 2002, Melbourne, Australia, 18 - 21 August 2002.

AusBiotech's 1350 participants included over 130 international delegates from Germany, UK, India, Canada, New Zealand, Taiwan, Israel, China, Japan and the U.S. With a conference theme of "Building Excellence Through Partnerships," much of the emphasis was placed on commercialization. The vast array of biotechnology research and development is due in part to research costs in Australia cost running about 1/2 the cost of similar work done in the U.S. primarily due to lower labor costs.

A highlight of the conference was the presentation by AMBRI Corporation on their work in the sensing area using tether-bilayer lipid membranes coupled to an antibody that targets a compound of diagnostic interest. This device provides rapid quantitative results. Another highlight was a poster by a graduate student of the Univ. of Queensland, Angus Johnson, titled "Novel Functionalized Ceramics & their use in Biotechnology." UQ is developing methods of synthesizing and analyzing a large number of chemical libraries (>1,000,000) using unique optical properties of the support particles. With small modifications to the surface groups on the support particles, this technology can be adapted to synthesizing peptides, oligonucleotides, and other biologically important molecules. www.ausbiotech.org (Brewer)

Material Science

Contract awarded: "The structures of rigid-rod polymers used for a supporting substrate for the microcomposite proton exchange membrane," Prof. Soo-Young Park, Department of Polymer Science, Kyungpook National University, Daegu, Korea, November 2002. Prof. Park will investigate by means of X-ray diffraction and molecular-modeling techniques the structures of new rigid-rod polymers that are candidates for use in proton-exchange membranes. Efforts will focus on atomic and microscopic characterization of naphthalene-based polymers. Rigid-rod polymers have advantages of exceptionally high strengths and dimensional stabilities, excellent resistance to chemical attack, good high-temperature properties, and readily tailored structures. The new class of rigid-rod polymers exhibits promise for use in many applications, but much has yet to be determined about their structures and properties. (Goretta)

Contract awarded: "Oxidation behavior of gamma TiAl alloys at elevated temperature," Dr. Michiko Yoshihara, Graduate School of Engineering, Yokohama National University, Yokohama, Japan, November 2002. Dr. Yoshihara will study oxidation kinetics and scale morphologies of thermal oxides grown on new TiAl alloys. These new alloys developed by Dr. Young-Won Kim at WPAFB have been designed to exhibit superior oxidation resistance. Prof. Yoshihara will conduct isothermal oxidation studies, cyclic tests to 1800 F, studies of effects of cooling rate, measurements of thermal expansion and scale strength, and microstructural studies. (Goretta)

Contract awarded: "The relationship between microstructure, mechanical properties and durability of geopolymeric materials," Prof. Jannie van Deventer, Department of Chemical Engineering, University of Melbourne, Australia, September 2002. Prof. Van Deventer and his colleagues will investigate the fundamental relationships between microstructure, mechanical properties, and durability of new geopolymeric materials. Geopolymers share many properties and processing routes with conventional materials such as cements and fired ceramic. As with cements, they form by a chemical reaction at near room temperature and can incorporate a wide range of products such as fly ash or granulated blast-furnace slag. Unlike cements, but similar to fired ceramics, they do not consist of hydrated crystals and thus their thermal stabilities can be quite good. In this work, specific emphasis will be placed on the role of calcium in geopolymerization and resulting structures and properties. (Goretta)

Site Visit: Institute of Materials Research and Engineering (IMRE), Singapore, November-December 2002. IMRE is affiliated with the National University of Singapore (NUS). Its mission to conduct basic and applied research across a broad spectrum of materials challenges is supported by both governmental and private funds. The governmental portion of current funding mix of nearly S\$30M is >80%. The private portion, though now relatively small, has shown consistent growth. IMRE's flexible structure allows its staff to host 50 graduate students from domestic and foreign universities and to collaborate nationally and internationally. IMRE's staff of 120 is remarkably young, with only 5% being 45 or older. Approximately half of the staff possesses a Ph.D. degree. Many hold joint appointments with NUS.

IMRE is organized by laboratories and scientific clusters. Its Director, Prof. Albert Yee, has stressed development of programs with high potential for significant technological advancement and strong future funding. IMRE's approach allows for efficient shifting of personnel and resources to where they are most needed. Current groupings are: Molecular and Biomaterials Laboratory, Materials Science and Characterization Laboratory, Micro- and Nano-Systems Laboratory, Materials Theory and Modelling Laboratory, Chemical Systems Cluster, and Opto- and Electronic Systems Cluster. Their research emphasis matches that of Singapore as

a whole. Nanotechnology comprises nearly half of the projects and biotechnology and modeling are key pursuits.

The facilities at IMRE are new and the laboratories are very well equipped. IMRE maintains a strong balance sheet, with significant cash reserves. It is positioned to focus on important emerging materials technologies, to interact effectively with national and international partners, and to make significant contributions to materials research and Singapore's economy. <http://www.imre.org.sg/> (Lyons/Goretta)

Conference: The Sixth Composites Durability Workshop (CDW-6), 13-15 November 2002, Tokyo, Japan. This series of workshops focuses on advanced concepts and methodologies related to the durability of polymer-matrix composites. The recent AOARD-supported workshop was conducted as a short course on new software for use in composite design and properties prediction. The presentations were: Introduction, Prof. Stephen Tsai (Stanford University); Micromechanics models and analysis, Dr. Jeffrey Wollschlager (Boeing), who substituted for Prof. Sung-Kyu Ha (Hanyang University); Strain invariant failure theory (SIFT), Dr. Jonathon Gosse (Boeing); SIFT analysis using StressCheck, Dr. Jeffrey Wollschlager; Accelerated testing methodology, Prof. Yasushi Miyano (Kanazawa Institute of Technology); Fracture models and analysis, Prof. Tong. E. Tay (National University of Singapore); Durability analysis, Dr. Akira Kuraishi (Stanford University); and software demonstration and instruction. The approaches that were presented allow for accurate prediction of the properties of laminated composites, with minimal testing on relatively simple specimens to confirm the predictions. SIFT methodology has led to savings of millions of dollars in the aerospace industry alone. The contributions from Profs. Miyano and Tay will extend the current capabilities of SIFT-based approaches and lead to significant advances in design optimization and component reliability and long-term cost. (Goretta)

Window-on-Science Visit: Dr. Shigeaki Uchida, Institute for Laser Technology, Osaka, Japan, 5-8 November 2002. Dr. Uchida attended the 1st International Symposium on Beamed Energy Propulsion (ISBEP) in Huntsville, AL. He met with Drs. Frank Meade and Bill Larson of AFRL/PR and others to discuss his recent work on laser/materials interactions that feature a liquid layer on a solid plate. Dr. Uchida also met with the organizers of ISBEP. It was decided that a second ISBEP will be held in Sendai, Japan, in the autumn of 2003, and that its organizers are to be Dr. Uchida and three other Japanese scientists (Drs. Niino, Yabe, and Sasoh). Its format will be similar to that of the first symposium. (Goretta)

Conference: Geopolymers 2002, 28-29 October 2002, Melbourne, Australia. Geopolymers are inexpensive alumino-silicate ceramics that require minimal energy to process and are environmentally friendly. They have proven successful in many structural applications, but, in large part because of their compositional and structural complexities,

relatively little is known about many of their properties in monolithic or composite forms. Much of the program was devoted to current research in geopolymers. Additional topics included global and local trends in geopolymer technology, emerging markets and market analysis, international and national business opportunities, case studies on commercializing technology, environmental applications, and economics. The conference advanced the state of understanding of geopolymers and promoted their use in an expanding range of applications.

<http://www.geopolymer2002.com/> (Goretta)

Site Visit: Japan Ultra-high Temperature Materials Research Institute (JUTEMI), Ube, Japan; 21 October 2002. The facilities and staff of JUTEMI represent a unique concentration of capabilities and expertise in high-temperature materials. Since its inception in 1990, JUTEMI's programs have expanded to cover processing, modeling, testing, and characterizing of a wide range of materials and properties. Its programs focus on bulk materials and films. Several pieces of equipment, such as hot presses and hot-isostatic presses, can operate to temperatures as high as 2500-3000°C. <http://www.jutem.co.jp> (Goretta)

Site Visit: Materials Science and Engineering Programs, University of Sydney, Sydney, Australia; 31 October – 1 November 2002. The laboratories of three professors were visited. Prof. Liyong Tong of the Department of Aeronautical Engineering has worked through AOARD over the past few years. He concentrates on studies of composite structures, bonding, and mechanical testing. Prof. Andrew Ruys of the Centre for Advanced Materials Technology focuses much of his work in ceramics on processing nanocomposites, functional grading of ceramic composites, and producing novel coated biomaterials. Prof. Simon Ringer of the Australian Key Centre for Microscopy & Microanalysis heads the Electron Microscope Unit and directs a nanomaterials center. His work is aimed at understanding microstructure in detail and manipulating materials on a nanometer scale to produce superior properties. (Goretta)

Site Visit: Department of Polymer Science and Engineering, Hannam University, Daejeon, Korea; 25-6 September 2002. Hannam University boasts one of the strongest polymer departments in Korea. The University itself was founded in 1956 as a Christian college. Consistent growth of enrollment (>12,000 now), faculty, and programs led to its elevation to full university status in 1982. Research within the Department concentrates in three main pursuits: (1) microelectronics and photo-functional polymers for sensors, conductors, nonlinear optics, and luminescent applications; (2) high-performance polymers, including liquid-crystal and organometallic polymers and structural composites; and (3) biomedical polymers for drug delivery, artificial organs, and in-vivo implants. Activities include polymer synthesis, composite and component fabrication, testing and characterization, and modeling and simulation.

The nearby laboratory of Prof. Young-Soo Park, Department of Polymer Science, Kyungpook National

University, Daegu, was also visited. Prof. Park is an expert in structural analysis of polymers. His work features detailed characterization by X-ray diffraction and other techniques, coupled with numerical simulation to further elucidate structural details. (Goretta)

Window-on-Science Visit: Prof. Tong E. Tay, Department of Mechanical Engineering, National University of Singapore, 12-18 September 2002. Prof. Tay visited WPAFB and then traveled to Stanford, CA, to present a paper at the 10th U.S.-Japan Conference on Composite Materials. At WPAFB, he was hosted by Dr. Steven Donaldson and his colleagues in ML. On his first day, Prof. Tay presented a seminar entitled "Non-self-similar delamination growth in composites." On his second day, he participated in a one-day workshop on composite joint analysis. In Stanford, Prof. Tay presented a paper entitled "Element-failure concepts for dynamic fracture and delamination in low-velocity impact of composites." He held discussions throughout his travels on strain invariant failure theory (SIFT) and how his techniques for assessment of damage can be incorporated into SIFT methodologies. Many areas of common interest and topics for potential research proposals were identified. (Goretta)

Micro & Nano Systems

Conference: Advanced nano-bio device project; Tokyo, Japan; 20 December 02. This workshop presented a new \$5M national project to be organized by NEDO from 2003 to 2005. The objective is to fuse nanotechnology with biotechnology, and develop next generation nanodevice technology which is useful for analyzing biomolecules under the condition of high sensitivity and ultra fast, low cost operation. In more concrete terms, two issues are to be addressed: *formulating nano-scale biomolecules and information analysis devices*, and *developing measurement technology of nano-scale bio information*. Advanced analyzing equipment such as ultra fast gene-finding and ultra fast protein-finding systems will provide useful bio information from measurement of a small quantity (microliter) of bio specimen. It is also useful for tailoring medical cure, preventive medical care, and the development of epoch-making drugs.

A panel discussion for supporting the project was held with six key figures such as Prof. Kawai of Osaka Univ. and Prof. Horiike of Tokyo Univ. A variety of activities were exhibited. Long term goals include development of a bio simulation chip and direct STM observation of DNA double helix structure to establish a single molecule metrology (for example, micro-TAS).

<http://www.netforum-nedo.com>. (Miyazaki)

Conferences: Two workshops on nanotechnology were held in succession last November. Both were based on government projects supported by MEXT (The Ministry of Education, Culture, Sports, Science and Technology).

Activities of Nano-Foundries, Tokyo, Japan, 25 November 02.

MEXT started the project in 2002 for the purpose of “total support” of searching information and using facilities. Nanotechnology Researchers Network Center of Japan (nanonet) collects and evaluates information domestically and internationally. It connects researchers’ facility requirements to those that are available for use. Nano-Foundries include the following five facilities; Independent Administration Institution National Institute of Advanced Industrial Science and Technology (AIST), Waseda University Nanotechnology Research Laboratory, Tokyo Institute of Technology Research Center for Quantum Effect Electronics, Hiroshima University Research Center for Nanodevices and Systems, and Osaka University Nanoscience and Nanotechnology Center. All facilities are available for use to any Japanese researchers including academia, industry and national institutes. Included in the four invited talks were *Collaborative Research Centers in USA in Electronics* (Prof. Saraswat of Stanford Univ.) and *Applications of Carbon Nanotubes to Electronic Devices* (Dr. Matsumoto of AIST). <http://www.nanonet.go.jp>.

Nano-Photonic and Electron Devices Technology Project, Tokyo, Japan, 26 November 02.

A new Nanoelectronics Collaboration Research Center (NCRC) was established at the University of Tokyo in 2002 for the purpose of realizing core technologies for development of the ubiquitous information devices based on nanotechnologies. The project has been jointly run with the METI government project “Development of Photonic Network Devices.” The project consists of four main research subjects:

- Fabrication technologies of quantum dots,
- Fabrication technologies of photonic nanostructures,

- Manipulation of electrons and photons in nanostructures, and
- Development of nano-photonic and electron devices.

The workshop focused on *Development of research for the nano-photonic and electron devices projects at NCRC* (Prof. Arakawa, Univ. of Tokyo), *Research on nano-devices for quantum information and communication technologies* (Prof. Yamamoto, Stanford Univ.), *Progress and perspective of quantum dot lasers* (Prof. Forchel, Univ. of Wuerzburg), *Evolution and prospects of nanostructure electronic devices* (Prof. Sakaki, Univ. of Tokyo), and *Present status and future prospects of photonic crystals and their applications* (Prof. Noda, Kyoto Univ.). <http://www.ncrc.iis.u-tokyo.ac.jp> . (Miyazaki)

Symposium: Eighth International Micromachine/Nanotech Symposium, Tokyo Japan, 14 November 02.

The Micromachine Symposium series grew out of the earlier national micromachine project. The project successfully built enough inertia to see efforts continue past the project’s end. The noteworthy addition to this year’s symposium is the addition of a formal “nanotech” component. In the accompanying exhibition, the change was noticeable. Gone were the micro-robots while the number of micro and nano fabrication firms represented doubled. The keynote speech by Prof. Isao Shimoyama of the Univ. of Tokyo was *Strategy towards Fusion of Nano and Micro Systems* and among other things, addressed a future vision that brings together biomedical, wearable, and networking technologies. <http://www.mesago-messefrankfurt.com/micro/en/> (Nowack)

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DATE	CONFERENCE	PLACE
Feb 2-8, 03	International Society for Plant Pathology (ICPP 2003)	Christchurch, New Zealand
Feb 3-7, 03	3 rd World Congress on Medicinal and Aromatic Plants (WOCMAP III)	Chiang Mai, Thailand
Feb 4-7, 03	Australian Computer Science Week 2003 (ACSW 2003)	Adelaide, Australia
Feb 4-7, 03	Fourth Australasian User Interface Conference (AUIC2003)	Adelaide, Australia
Feb 6-7, 03	9th Symposium on Microjoining and Assembly Technology in Electronics (Mate 2003)	Yokohama, Japan
Feb 10-14, 03	Conference on Permutation Patterns	Dunedin, New Zealand
Feb 11-14, 03	International Conference on Computer Graphics and Interactive Techniques in Australia and South East Asia	Melbourne, Australia
Feb 17-18, 03	HUMS2003 - DSTO International Conference on Health and Usage Monitoring	Melbourne, Australia
Feb 18-21, 03	The 3 rd International Display Manufacturing Conference & Exhibition	Taipei, Taiwan
Feb 19-22, 03	International Display Manufacturing Conference (IDMC 2003)	Taipei, Taiwan
Feb 2003	12th Australian Electrochemistry Conference (12AEC)	Hobart, Australia
Mar 1-4, 03	International Conference on Fuzzy Information Processing: Theories and Applications	Beijing, China
Mar 2-7, 03	Fifth International Workshop on Nonlinear Waves and Chaos in Space Plasmas. Indian Institute of Geomagnetism.	Maharashtra, India
Mar 3-5, 03	2nd Workshop on Mechano-Electromagnetic Property of Composite Superconductors	Kyoto, Japan
Mar 3-7, 03	International Conference on Low Energy Antiproton Physics (LEAP '03)	Yokohama, Japan
Mar 5-8, 03	19th International Conference on Data Engineering	Bangalore, India
Mar 9-13, 03	The Fifth International Conference on Fatigue and Transportation	Fremantle, Australia
Mar 10-11, 03	Multi-lingual Information Management (RIDE-MLIM'2003)	Hyderabad, India
Mar 11-13, 03	8th Atmospheric Sciences and Application to Air Quality (ASAAQ 2003)	Tsukuba, Japan
Mar 13-15, 03	The First International Conference on Green & Sustainable Chemistry	Tokyo, Japan
Mar 13-15, 03	The 3rd International Conference on Numerical Analysis in Engineering (NAE2003)	Batam Island, Indonesia
Mar 16-19, 03	8th International Symposium on Plasticity and Impact Mechanics	New Delhi, India
Mar 19-22, 03	The 1st International Symposium on Point Defect and Nonstoichiometry in Semiconductors (ISPN2003)	Sendai, Japan
Mar 20-22, 03	1st International Symposium on Point Defect and Nonstoichiometry	Sendai, Japan
Mar 21-23, 03	IEEE 2003 International Conference on Computational Intelligence for Financial Engineering (CIFEr2003)	Hong Kong, China
Mar 26-28, 03	8th International Conference on Database Systems for Advanced Applications	Kyoto, Japan
Mar 26-28, 03	7th International Symposium on Power-Line Communications and Its Applications (ISPLC2003)	Kyoto, Japan
Apr 1-4, 03	2003 Fourth International Symposium on Independent Component Analysis and Blind Separation	Nara, Japan
Apr 2-4, 03	FEF-03 Finite Elements on Flow Problems	Nagoya, Japan

Apr 3-4, 03	International Workshop on Synthesis and System Integration of Mixed Information Technologies 2003 (SASIMT 2003)	Hiroshima, Japan
Apr 6-10, 03	IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP'2003)	Hong Kong, China
Apr 6-10, 03	International Conference on Acoustics, Speech and Signal Processing (ICASSP)	Hong Kong, China
Apr 9-11, 03	International Ceramic Exhibition 2003, Concurrent Conference: 2nd Fulrath Memorial Symposium on Advanced Ceramics	Tokyo, Japan
Apr 14-16, 03	ISCA Workshop on Spontaneous Speech Processing and Recognition.	Tokyo, Japan
Apr 14-17, 03	International Conference on Non Ionizing Radiation (ICNIR)	Kuala Lumpur, Malaysia
Apr 15-19, 03	21st AIAA International Communications Satellite Systems Conference & Exhibit (AIAA ICSSC-21)	Yokohama, Japan
Apr 16-18, 03	Photomask Japan 2003	Yokohama, Japan
Apr 16-18, 03	Cool Chips VI-An International Symposium on Low-Power and High-Speed Chips	Yokohama, Japan
Apr 18-22, 03	3rd International EMF Seminar in China	Guilin, China
Apr 20-23, 03	Eleventh International Conference on Nuclear Engineering (ICONE-11)	Tokyo, Japan
Apr 21-24, 03	The Sixth International Nobeyama Workshop on the New Century of Computational Fluid Dynamics	Nobeyama, Nagano, Japan
Apr 28-29, 03	9 th World Micromachine Summit	Beijing, China
Apr 30- 2 May 03	The Seventh Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD-03)	Seoul, Korea
May 3-5, 03	First International Conference on Smarandache Geometries (Mathematics)	Gold Coast, Australia
May 7-11, 03	ICIAM 2003 The 5th International Congress on Industrial and Applied Mathematics (Mathematics)	Sydney, Australia
May 11-15, 03	7th International Conference on Organic Nonlinear Optics (ICONO7) / International Conference on Organic Photonics and Electronics (ICOPE 2003)	Sorak National Park, Korea
May 11-16, 03	3rd World Conference on Photovoltaic Energy Conversion	Osaka, Japan
May 12-15, 03	IEEE International Symposium on Cluster Computing & the Grid (CCGrid 2003)	Tokyo, Japan
May 12-16, 03	International Conference on Shape Modeling & Applications (SMI 2003)	Seoul, Korea
May 12-17, 03	IEEE International Conference on Robotics and Automation (ICRA 2003)	Taipei, Taiwan
May 14-16, 03	The 6th IEEE International Symposium on Object-Oriented Real-Time Distributed Computing (ISORC-2003)	Hakodate, Japan
May 16-19, 03	33rd International Symposium on Multiple-Valued Logic (ISMVL 2003)	Tokyo, Japan
May 18-23, 03	The 4th International Conference on Intelligent Processing and Manufacturing of Materials (IPMM'03)	Sendai, Japan
May 19-22, 03	SAE "Spring" Fuels & Lubricants Meeting	Yokohama, Japan
May 19-22, 03	7th Southeast Asian Ergonomics Society and 4th Malaysian Ergonomics Conference (SEAMEC 2003)	Kuching, Malaysia
May 19-23, 03	The 7th International Symposium on Artificial Intelligence, Robotics and Automation in Space (i-SAIRAS 2003)	Nara, Japan
May 20-24, 03	The First International Congress on Bio-Nanointerface	Tokyo, Japan
May 25-28, 03	IEEE International Symposium on Circuits and Systems (ISCAS 2003)	Bangkok, Thailand
May 25-30, 03	The 5th International Conference on Nitride Semiconductors (ICNS-5)	Nara, Japan
May 26-28, 03	5th International Conference on Stochastic Structural Dynamics (SSD-03)	Hangzhou, China
May 26-29, 03	4 th International Conference of Physical and Numerical Simulation of Materials Processing	Shanghai, China
May 26-30, 03	The 7th Asian Symposium on Visualization (7ASV)	Singapore
May 28-30, 03	Third International Conference on Fatigue of Composites (ICFC 3)	Kyoto, Japan
May 28-Jun 2, 03	International Symposium on Different Structural Biology 2003 (ISDSB2003)	Tsukuba, Japan
Jun 1-5, 03	7th International Conference on Properties and Applications of Dielectric Materials (ICPADM 2003)	Nagoya, Japan
Jun 2-4, 03	The 3rd International Conference on Computational Science	Melbourne, Australia
Jun 3, 03	The 9th International Conference on Radiation Curing (Red Tech Asia 2003)	Yokohama, Japan

Jun 2-5, 03	30th IEEE International Conference on Plasma Science (ICOPS 2003)	Jeju, Korea
Jun 6-9, 03	Optical Amplifiers and Their Application (OAA2003)	Otaru, Japan
Jun 8-9, 03	2003 Silicon Nanotechnologies Workshop	Kyoto, Japan
Jun 9-12, 03	Symposium on VLSI Technology	Kyoto, Japan
Jun 11-13, 03	The 7 th International Symposium on Sputtering and Plasma Process	Kanagawa, Japan
Jun 11-13, 03	International Symposium on Macro-, Micro- and Nano-Mechanics of Materials	Hong Kong, China
Jun 11-14, 03	Symposium on VLSI Circuits	Kyoto, Japan
Jun 15-18, 03	JSME-IIP/ASME-ISPS Joint Conference on Micromechatronics for Information and Precision Equipment (IIP/ISPS Joint MIPE)-2003	Yokohama, Japan
Jun 16-18, 03	2003 JSME-IIP/ASME-ISPS Joint Conference on Micromechatronics for Information and Precision Equipment	Yokohama, Japan
Jun 23-25, 03	International Conference on Advances in Structural Engineering	Sydney, Australia
Jun 24-29, 03	International Conference on Heterogeneous Materials Mechanics	Chongqing, Three Gorges, China
Jun 25-27, 03	Third International Symposium on Turbulence and Shear Flow Phenomena	Sendai, Japan
Jun 25-27, 03	Scientific Submarine Cable 2003 (SSC03) Workshop	Tokyo, Japan
Jun 27-Jul 02, 03	IEEE International Symposium on Information Theory 2003 (TSFP-3)	Yokohama, Japan
Jun 29-Jul 4, 03	International Conference on Materials for Advanced Technologies (ICMAT 2003)	Singapore
Jun 29-Jul 5, 03	2003 IEEE International Symposium on Information Theory (ISIT2003)	Yokohama, Japan
Jun 30-Jul 3, 03	The 5th Asian Computational Fluid Dynamics Conference	Busan, Korea
Jun 30-Jul 11, 03	XXIII General Assembly of the International Union of Geodesy and Geophysics (IUGG)	Sapporo, Japan
Jul 6-11, 03	STRINGS 2003 (Mathematics)	Kyoto, Japan
Jul 6-11, 03	XIX International Congress of Genetics	Melbourne, Australia
Jul 7-11, 03	International Superconducting Electronics Conference	Sydney, Australia
Jul 7-11, 03	The 16 th International Vacuum Microelectronics Conference	Osaka, Japan
Jul 7-11, 03	5 th International Congress on Industrial and Applied Mathematics	Sydney, Australia
Jul 8-11, 03	The sixth International Conference on Information Fusion (FUSION 2003)	Cairns, Australia
Jul 9-11, 03	Computer Graphics International Conference (CGI 2003)	Tokyo, Japan
Jul 13-26, 03	XXVth IAU General Assembly. The International Astronomical Union.	Sydney, Australia
Jul 14-17, 03	Modeling and Simulation Society of Australia and New Zealand, CSIRO Land and Water (MODSIM 2003)	Queensland, Australia
Jul 14-18, 03	The 11 th International Conference on Modulated Semiconductor Structures (MSS11)	Nara, Japan
Jul 14-18, 03	The 15 th International Conference on Electronic Properties of Two-Dimensional Systems (EP2DS-15)	Nara, Japan
Jul 14-18, 03	The Second International Joint Conference on Autonomous Agents and Multi-Agent Systems	Melbourne, Australia
Jul 15-18, 03	Interopt 2003	Chiba, Japan
Jul 16-17, 03	10 th Femtosecond Technology Conference (FST2003)	Chiba, Japan
Jul 16-20, 03	International Symposium on Computational Intelligence in Robotics and Automation (CIRA 2003).	Kobe, Japan
Jul 20-24, 03	IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM2003)	Kobe, Japan
Jul 20-25, 03	The 24th International Symposium on Shock Waves	Beijing, China
Jul 22-26, 03	Conference on Lasers & Electro-Optics & The Pacific Rim Conference on Lasers and Electro-Optics (CLEO/PACIFIC RIM 2003)	Taipei, Taiwan, Republic of China
Jul 26-31, 03	XXIs International Conference on Photochemistry (ICP21)	Nara, Japan
Jul 26-31, 03	21 st International Conference on Photochemistry (ICP21)	Nara, Japan

Jul 29- Aug 1, 03	IEEE International Conference on Multisensor Fusion and Integration for Intelligent Systems (MFI 2003)	Tokyo, Japan
Jul 31-Aug 7, 03	28 th International Cosmic Ray Conference	Tsukuba, Japan
Aug 13-18, 03	Thirteenth International Heat Transfer Conference	Sydney, Australia
Aug 16-19, 03	AusBiotech	Adelaide, Australia
Aug 17-21, 03	6th International Symposium on Antennas, Propagation & EM Theory (ISAPE-2003)	Beijing, China
Aug 19-22, 03	International Symposium on Speed-up and Service Technology for Railway and MAGLEV Systems (STECH2003)	Tokyo, Japan
Aug 24-29, 03	The XVth Triennial Congress of the International Ergonomics Association, Symposium on: Cognitive Ergonomics – World-Wide Perspectives	Seoul, Korea
Aug 24-29, 03	World Congress on Medical Physics and Biomedical Engineering - WC2003.	Sydney, Australia
Aug 25-29, 03	18th IAVSD Symposium	Atsugi, Japan
Aug 26-28, 03	International Conference on Computational Mesomechanics (Mesomechanics 2003)	Tokyo, Japan
Sep 1-5, 03	18th International Radiocarbon Conference. Rafter Radiocarbon Laboratory of the Institute of Geological and Nuclear Sciences.	Wellington, New Zealand
Sep 3-5, 03	Australian International Conference on Radar (RADAR 2003)	Adelaide, Australia
Sep 3-5, 03	IEEE 9th International Software Metrics Symposium (Metrics 2003)	Sydney, Australia
Sep 8-11, 03	2003 International Workshop on Acoustic Echo and Noise Control (IWAENC2003)	Kyoto, Japan
Sep 10-12, 03	International Conference on Advanced Technology in Experimental Mechanics 2003 (ATEM '03)	Nagoya, Japan
Sep 16-25, 03	The 12th Mathematical Society of Japan, International Research Institute (12th MSJ-IRI), "Singularity Theory and its Applications"	Sapporo, Japan
Sep 29-Oct 2, 03	The 5th International Meeting of Pacific Rim Ceramic Societies (PacRim 5)	Nagoya, Japan
Oct 8-13, 03	The 8th IUMRS International Conference on Advanced Materials (IUMRS-ICAM 2003)	Yokohama, Japan
Oct 7-10, 03	International Symposium on Mixed & Augmented Reality (ISMAR 2003)	Tokyo, Japan
Oct 12-15, 03	IEEE Intelligent Transportation Systems Conference (ITSC 2003)	Shanghai, China
Oct 13-17, 03	International Conference on Intelligent Agent Technology. Web Intelligence Consortium (WIC) (IAT 2003)	Beijing, China
Oct 19-23, 03	IEEE International Telecommunications Energy Conference (INTELEC 2003)	Yokohama, Japan
Oct 20-22, 03	The 5th International Conference on Fracture & Strength of Solids	Sendai, Japan
Oct 22-26, 03	International Symposium on New Perspectives in Shell and Spatial Structures	Taipei, Taiwan
Oct 27-29, 03	16 th International Symposium on Superconductivity (ISS 2003)	Tsukuba, Japan
Oct 29-31, 03	The 9 th Microoptics Conference (MOC'03)	Tokyo, Japan
Nov 1-5, 03	The 3 rd China International Conference on High Performance Ceramics	Shenzhen, China
Nov 2-6, 03	The Third International Conference on Light Materials for Transportation Systems (LiMAT 2003)	Honolulu, Hawaii
Nov 2-7, 03	International Gas Turbine Congress 2003 Tokyo	Tokyo, Japan
Nov 3-7, 03	11th Asia-Pacific Conference on Non-Destructive Testing	Seoul, Korea
Nov 3-8, 03	3rd International Symposium on Slow Dynamics in Complex Systems	Sendai, Japan
Nov 4-7, 03	3rd Asia-Pacific Conference on Environmental Electromagnetics (CEEM 2003)	Zhejiang, China
Nov 6-12, 03	World Health Organization & US Air Force Asia Pacific EMF Conference	Bangkok, Thailand
Nov 9-13, 03	International Conference on Power Engineering-03 (ICOPE-03)	Kobe, Japan
Nov 16-20, 03	The 7th International Conference on Atomically Controlled Surfaces, Interfaces and Nanostructures	Nara, Japan
Nov 18-21, 03	Japan International SAMPE Symposium and Exhibition	Tokyo, Japan
Dec 1-3, 03	International Symposium on Micro-Mechanical Engineering -Heat Transfer, Fluid Dynamics, Reliability and Mechatronics (ISMME 2003)	Tsukuba, Japan
Dec 7-11, 03	The 4th International Conference on Fluid and Thermal Energy Conversion	Bali Island, Indonesia

Dec 8-12, 03	Congress on Evolutionary Computation (CEC 2003)	Canberra, Australia
2003	Pacific Rim Radio Frequency Radiation Conference (Moved from Nov 4-7, 2002)	Bangkok, Thailand
Jan 5-7, 04	17th National and 6th ISHMT-ASME Heat and Mass Transfer Conference	Tamil Nadu, India
Apr 4-9, 04	18th International Congress of Acoustics (18th ICA)	Kyoto, Japan
May 16-21, 04	7th World Biomaterials Congress	Sydney, Australia
May 31- Jun 3, 04	International Conference on Multiphase Flow (ICMF-2004)	Yokohama, Japan
Jun 7-10, 04	24th CIMAC Congress 2004 in Kyoto (CIMAC KYOTO 2004)	Kyoto, Japan
Jul 25-28, 04	47th IEEE Midwest Symposium on Circuits and Systems (MWSCAS)	Hiroshima, Japan
Aug 29- Sep 3, 04	24th Congress of the International Council of the Aeronautical Sciences (ICAS 2004)	Yokohama, Japan
Dec 17-19, 04	International Conference on Recent Advances in Composite Materials	Varanasi, India

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